Managing the Roads Most Traveled

THE TRANSPORTATION NETWORK

The Michigan Department of Transportation (MDOT) is responsible for assuring the mobility of our citizens, visitors and business interests. To do this, the department must manage four types of transportation assets: marine, nonmotorized, rail and road. Keeping track of data on this modal infrastructure requires a comprehensive inventory system, able to uniquely identify not only a specific segment, but individual points along that segment. These are called a *linear referencing* systems.

HISTORICAL BACKGROUND

Formal linear referencing as we know it in Michigan today dates from the sixties, when Michigan State Police (MSP) began development of their *Michigan Accident Location Index* (MALI). Their goal was to record the location of, and data about, vehicular and pedestrian accidents (now called *crashes*). This would allow analysis of problem areas, and mitigation of their cause.

Though the original goal of MSP was to include rail lines and trails, when MDOT took over responsibility for MALI in October, 1996, only roads were included. This transfer was effected because the types of MALI use had far exceeded the original scope. MDOT was tasked with updating MALI to meet Michigan's broader needs. This will include marine, nonmotorized and rail segments.

THE WAY MOST TRAVELED

In any linear reference system, each contiguous transportation segment is given an identifier. In MALI, this is called a *Physical Reference* (PR) number. The PR number itself holds no meaning other than as a seven digit accounting key. To simplify accounting, segments do not cross county or state lines. In Michigan, the south or west end of the segment is designated *Beginning Mile Point* (BMP) and given a value of zero. The other end is designated *Ending Mile Point* (EMP) and given a value equal to the length of the segment. In this way, data for the segment, or any part thereof, can be referenced by PR milepoints.

The section of railway below is designated PR *1234567*. To store data on *Weekly Train Frequency*, it is necessary to show where the density of trains changes. To do this, we create a data table that records the PR number, BMP/EMP that define the part of the PR segment for which the data is valid, and the number of trains. This results in Table 1. Other data are stored in similar *unique* areas like Tables 2 and 3.

And this could just as easily be *Average Annual Daily Traffic* for a road, or *Vehicle Capacity* for a marine ferry or *Surface Type* for a bike path.

Table 1: Train Frequency

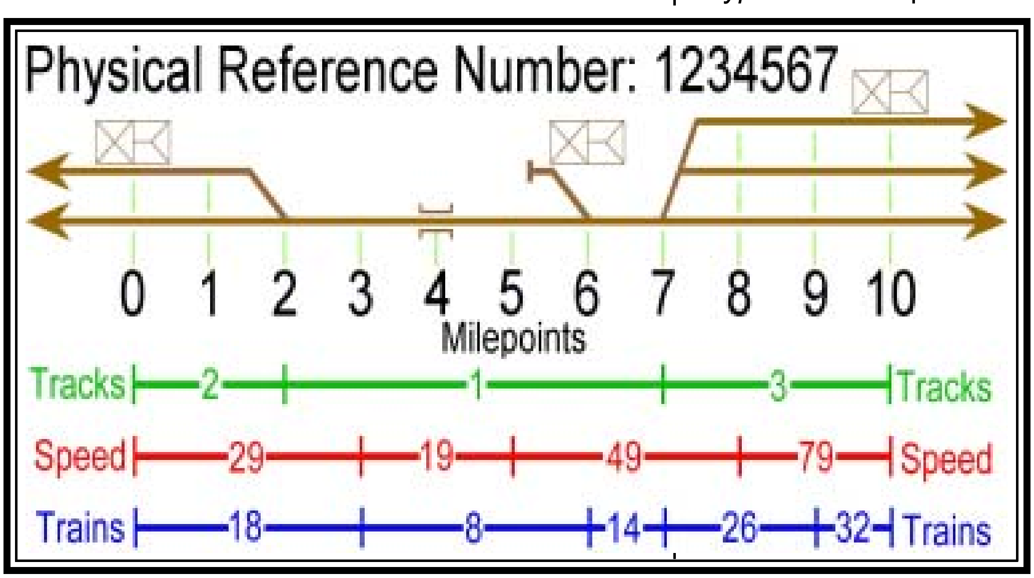
PR Nbr.	BMP	EMP	Trains
1234567	0.0	3.0	18
1234567	3.0	6.0	8
1234567	6.0	7.0	14
1234567	7.0	9.0	26
1234567	9.0	10.0	32

Table 2: Train Speed

PR Nbr.	BMP	EMP	Speed
1234567	0.0	3.0	29
1234567	3.0	5.0	19
1234567	5.0	8.0	49
1234567	8.0	10.0	79

Table 3: Tracks

PR Nbr.	BMP	EMP	Track
1234567	0.0	2.0	2
1234567	2.0	7.0	1
1234567	7.0	10.0	3



The Stops Along the Way

Linear reference systems also allow storage of data at points along the segment. In the previous rail example, there are three stations located along the line. To store data on these stations, the table would look like Table 4.

Table 4: Stations

PR Nbr.	MP	Stn.
1234567	0.0	West
1234567	6.0	Central
1234567	10.0	East

Once again, this data could just as easily be *Traffic Monitoring Equipment* on a road, or *Port Amenities* on a marine ferry.

Dynamic Segmentation

In this example, as well as in our actual database, segment data is stored one attribute to a table. Advantages to storing data this way include ease of data maintenance, greater flexibility in application development and improved application performance. However, most users analyze segments based on multiple attributes, as shown in Table 5. The process of joining multiple segment data tables is called *Dynamic Segmentation*.

Table 5: Tracks, Trains & Speed

PR Nbr.	BMP	EMP	Tracks	Trains	Speed
1234567	0.0	2.0	2	18	29
1234567	2.0	3.0	1	18	29
1234567	3.0	5.0	1	8	19
1234567	5.0	6.0	1	8	49
1234567	6.0	7.0	1	14	49
1234567	7.0	8.0	3	26	49
1234567	8.0	9.0	3	26	79
1234567	9.0	10.0	3	32	79

Geographic *Framework*

MALI gives those who need access to transportation data a common system of reference from which to work. Reference to other types of data require use of common map or data structures. The former is provided by *Geographic Information Systems* (GIS). MDOT and other state agencies cooperate in producing just such a map; called the *Michigan Geographic Framework* (commonly *Framework*). An example of the latter is a concordance with MDOT *Control Sections*.

Because of their flexibility and ability to answer questions in easily understood *pictures*, GIS often seems magical. However, users need to understand that a digital geography like *Framework* is really only a special kind of data; very useful, but just data nonetheless.

Who's Responsible?

The digital geography itself is the responsibility of the Michigan Information Center (MIC), a part of the Department of Management and Budget. They maintain the actual base map(s) and assure geographic data are accessible to all their customers, including MDOT and our governmental partners. In some instances, they also maintain a minimal levels of data directly related to shared business processes.

However, the transportation data necessary to support our business processes is still the responsibility of MDOT and our governmental partners.

How Accurate is the Map?

As technology has improved, the cost of maintaining an accurate digital geography has come down significantly. At this time, Framework claims an accuracy of two meters. That is to say, an object shown on the map will be within two meters of that objects actual place in the field. For most planning purposes, this is more than sufficient accuracy. However, continual evolution may someday lead to an even greater level of accuracy.

How Up to Date is the Map?

Michigan's transportation network is constantly evolving. New trails are established, roads are realigned and rail lines abandoned. To accommodate these changes, MIC has a process for transferring our old data to an updated linear reference. There is generally a two year lag in the network we use. This is understandable in light of the fact that we cannot begin the update until the close of the calendar year, and there are large numbers of governmental agencies which must report their changes. As this process becomes more routine, it is hoped that the lag time will decrease.

For Further Information

For more information on Linear Referencing, please contact Joyce Newell, at (517) 373-2334 or newellj@michigan.gov.

Highways are not always asphalt or concrete. M.V. Badger *forms the US-10 connection between Ludington, MI and Manitowoc, WI.*